A FUZZY APPROACH TO HANDLE UNCERTAINTY AND VAGUENESS IN LIFE CYCLE COSTING FOR AIR CONDITIONING SYSTEMS

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Dedication

To my parents

For their spiritual support through out my life…

Declaration

This thesis is a report on the research work carried out in the Department of Civil Engineering, University of Moratuwa, Sri Lanka. This submission is original and does not have any materials previously published or written by any others anywhere, except where citing is made.

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Abstract

Air conditioning cost being the most cost effective element of building services in buildings because of its higher operating cost. In order to select a cost benefited one among the available types a life cycle cost analysis can be applied. Life cycle costing (LCC) by its definition is totally based on predictions. Accuracy in its application depends on how far the predictions covers the reality, handles the uncertainties involved and ultimately how far predicting.

There are five major variables that contribute to the operating cost as well as to the inaccuracy of LCC. Those are: indoor temperature; outdoor temperature; relative humidity; number of occupants; and period of operating. These variables inherit very high uncertainty and vagueness. Thus, predictions and decision making has to provide space for handling them. The fuzzy set theory is employed to handle the inherent uncertainty and vagueness of the human decision making process. Hence, the hypothesis of the research was "Fuzzy expert system will address the problem".

Conducting interviews and questionnaire surveys, with air conditioning design experts, the knowledge for the knowledgebase and decision-making logic for inference engine of the system were established. Then the system was prototyped in MATLAB R11™. Traditional methods can process only descriptive data while fuzzy system can process both descriptive and non-descriptive (continuous) data and produce accurate output. For example, indoor temperature and number of occupants are changing almost every minute. This dynamicity is effectively accommodated in fuzzy membership functions. Since fuzzy systems can do multi-variant manipulating for sensitivity analysis, the contribution of all the input variables towards the output variable "change in operating cost" can be obtained at the same time. Finally, the developed system was tested for its accuracy in prediction of operating cost with data from hotel buildings covering the data taken from questionnaire survey and then with a real set of data to govern the whole system behavior. It exhibited 80% of accuracy. The thesis describes the approach, development of model and the testing in detail.

Key words: Life Cycle Costing (LCC), air conditioning, uncertainties, vagueness, Fuzzy logic

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Abbreviations

LCC - Life Cycle Costing

IT` - Indoor Temperature

OT - Outdoor Temperature

RH - Relative Humidity

CNO - Change in Number of Occupants

COC - Change in Operating Cost

CCL - Change in Cooling Load

LCCA - Life Cycle Cost Analysis

MF - Membership Function

FL - Fuzzy Logic

FST - Fuzzy Set Theory

COA - Center Of Area Defuzzification Method